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Gypsum crystals in the inner shelf sediments off Maharashtra, India

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Abstract

Gypsum crystals have been found in the inner shelf silty clay/clayey silt off the Maharashtra Coast between Vengurla and Bombay. Generally these occur as euhedral single or twinned crystals of selenite. Very often shells are found embedded within the crystals. The possible conditions of formation of the crystals are discussed and it is suggested that the crystals are non-evaporitic in origin.

Introduction

The study of the coarse fraction ($\gtrsim 62\mu$) of the sediment samples collected from the western shelf during the various cruises revealed the occurrence of gypsum crystals in the inner shelf sediments off Maharashtra. Gypsum crystals were observed in seventeen samples (Fig. 1), fifteen from a depth of less than 30 m and two from 31 to 47 m.

TABLE I. Weight percentage of gypsum crystals in coarse fraction*

S. No.	Sample No.	Depth m	Weight percentage
1	G2/1	26.5	9.6
2	3	22 5	3.3
3	4	20.5	22.7
4	5	13.5	1.3
5	6	18.5	8.1
6	7	16.5	3.1
7	T/0A	10.0	9.3
8	G2/8	22.5	16.7
9	9	12.0	16.0
10	S/00	10.0	5.4
11	R/00	8.0	9.2
12	G2/10	10.8	1.8
13	Q/00	8.0	22.6
14	G2/11	10.5	7.0
15	13	15.0	10.5
16	23	47.0	9.0
17	26	31.0	6.0

* Generally the coarse fraction of these samples is $< 5\%$.

The occurrence of such crystals in open ocean sediments at shallow depths is unusual. The present note records their occurrence and indicates their possible origin.

Description of the Crystals

Gypsum (*var.* Selenite) occurs as translucent to transparent euhedral to subhedral crystals (Fig. 2A) ranging from 0.05 to 3 mm. Well developed clinopinacoid (010), prism (110) and negative hemi-pyramid (111) are present but due to rounding of the pyramid some crystals have developed a lenticular habit (Fig. 2B). Few crystals show interpenetration twinning (Fig. 2C). Some crystals enclose well preserved shells of benthic foraminifera *Ammonia beccarii* (Fig. 2D) or pieces of molluscan shells. The weight percentages of these crystals in the coarse fraction are given in Table I.

Discussion

Generally the supratidal flat, tidal flat, semi-isolated marine pools, lagoons and the immediate waters adjacent to the lagoons, are the places in arid and semi-arid regions which favour the development of gypsum.

The present area of study is an open ocean and the environmental conditions are not favourable for the formation of gypsum as an evaporite. Being an open ocean, the values of salinity and pH of the water on an average varies from 35% to 36% and 8.19 to 8.62 respectively (Anon., 1974). The salinity is too low for the

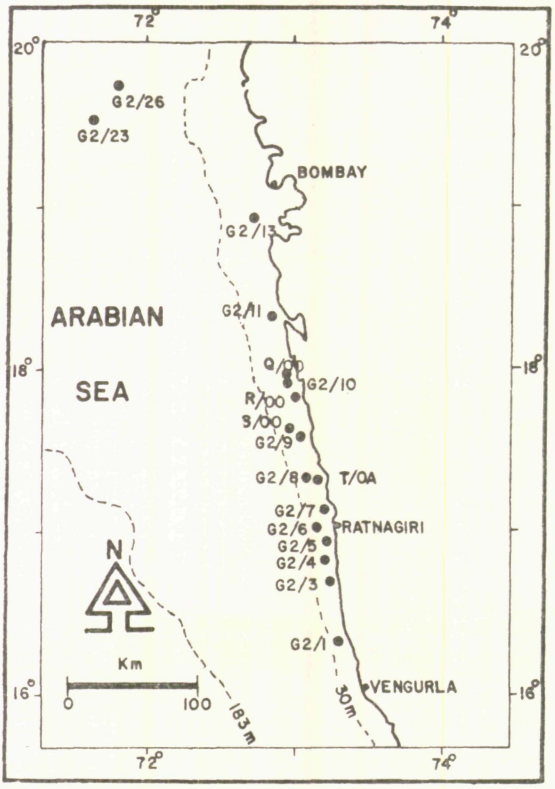

Figure 1. Location map showing gypsum (selenite) crystals bearing sediments.

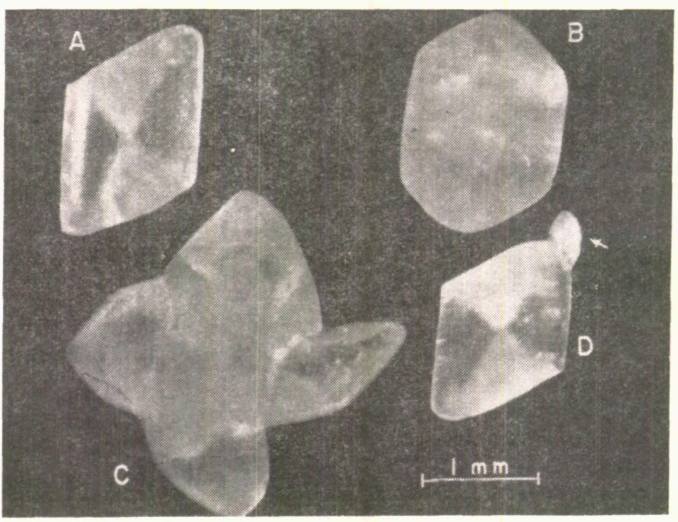

Figure 2. Gypsum (selenite) crystals.

A) Euhedral crystals.
B) Crystal with lenticular shape owing to rounding of the pyramid.
C) Crystals forming interpenetration twins.
D) Crystal enclosing foraminifera (indicated by arrow).

precipitation of gypsum, as gypsum precipitates when salinity reaches 117% (Elderfield, 1976) and for the dissolution of the calcium carbonate, the value of pH should be lower than 7.8 (Mason, 1966). Transportation of these crystals from other regions to this area is ruled out because (i) abrasional effects are not commonly found except in a few cases where rounding of pyramid is observed, (ii) the foraminifers embedded in the crystals are not broken, (iii) there is no possibility of these crystals coming from the land as the adjoining land is covered mostly by Deccan traps, (iv) environmental condition in the area and also along the coast are not favourable for the evaporation of water. Hence, a non-evaporitic and *in situ* origin of these crystals appear a possibility. The inner shelf sediments of the area, in addition to getting the supply of terrigenous sediments also get a large quantity of biogenic material from the overlying water. The high organic productivity of the overlying water is also reflected in the high values of organic matter, (average 3.56% on a dry weight basis in the sediment). The biogenic material after deposition in the terrigenous sediments starts decaying. In this process, at certain places, oxygen is consumed and local anaerobic conditions occur in the sediment. The micro-anaerobic condition is represented in the form of pyrite infilling of the shells and also by the presence of sulphide-sulphur (Paropkari *et al.*, 1977) in the inner shelf sediments off Bombay. Anaerobic bacteria thrive under these conditions and reduce sulphate present in the water and initiate the formation of hydrogen sulphide. The percentage of hydrogen sulphide producing bacteria present in the inner shelf sediments off Bombay ranges from 7.5 to 21.7% (Shantha Nair—Personal communication). This hydrogen sulphide reacts with the iron present in the sediment to form pyrite. The pyrite thus formed decomposes to generate sulphuric acid which reacts with the calcium carbonate to form gypsum. The example of gypsum associated with London and Oxford clays (Read, 1970) is analogous to the present gypsum forming environment.

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